Space Weather Technical Forecast

Issued on Saturday 22 February 2025 at 00:24 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-class flares likely. Possible glancing CMEs Days 2-3 (23-24 Feb).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate following two impulsive M-class flares from AR4000, with a peak M3.3 flare at 21/1215 UTC.

There are currently nine sunspot regions on the visible disc. The most notable regions are now AR3998 at south centre disc and newly numbered AR4000 approaching north centre disc. AR3998 continues to show spot development and magnetic complexity, maintaining a small delta spot within the developing intermediate portion. AR4000 has developed rapidly in the last 24 hours, with a clear delta spot in the trailing portion. AR3996 remains of interest, but despite its length it is straightforward magnetically, and currently appears stable. The other regions on the disc are smaller and simpler at the present time.

A filament lift off occurred in the northwest, starting around 21/1000 UTC, which is currently being assessed but is considered unlikely to have an Earth directed component. No other Earth directed CMEs have been seen in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, showed background conditions. Wind speeds varied between 300-400 km/s. Density was below average. Interplanetary Magnetic Field, Bt, was weak at 6nT or less. The north-south component, Bz, varied weakly between +4/-5 nT, but with a southward bias. Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was very slightly elevated above the normal background level, but well below the S1/Minor radiation storm threshold. High energy electron flux (greater than 2MeV) at GOES16 was mainly moderate, peaking at 356pfu at 21/1750 UTC. The associated 24-hour fluence was below the Active threshold (1e8 integrated pfu) on a slight rising trend, recording 1.55e7 integrated pfu at 22/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: The flare probability has been increased, mainly due to the development of AR4000, with M-flares now considered likely and a slight chance of X-flares.

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Solar Wind / Geomagnetic Activity: There have been several CMEs over the last few days, with confidence in this aspect of the forecast very low. There are two main features which may have the potential to affect Earth. Glancing blows are possible around the middle of the day (UTC) on Day 2 (23 Feb) and again on Day 3 (24 Feb). In addition, late Day 3 or Day 4 (24-25 Feb) a slight fast wind enhancement may occur, however at most wind speeds may become slightly elevated around 400-450 km/s.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled at first, but activity may increase to give a chance of G1/Minor Storm (Kp 5) intervals and a slight chance of G2/Moderate Storm (Kp 6) intervals on Days 2-3 mainly due to the risk of CME influence.

Energetic Particles / Solar Radiation: High energy proton flux is likely to persist at background levels, but with a slight chance of increasing above the S1/Minor radiation storm threshold in response to any larger flares. High energy electron flux is expected to be mainly at moderate levels. The associated 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

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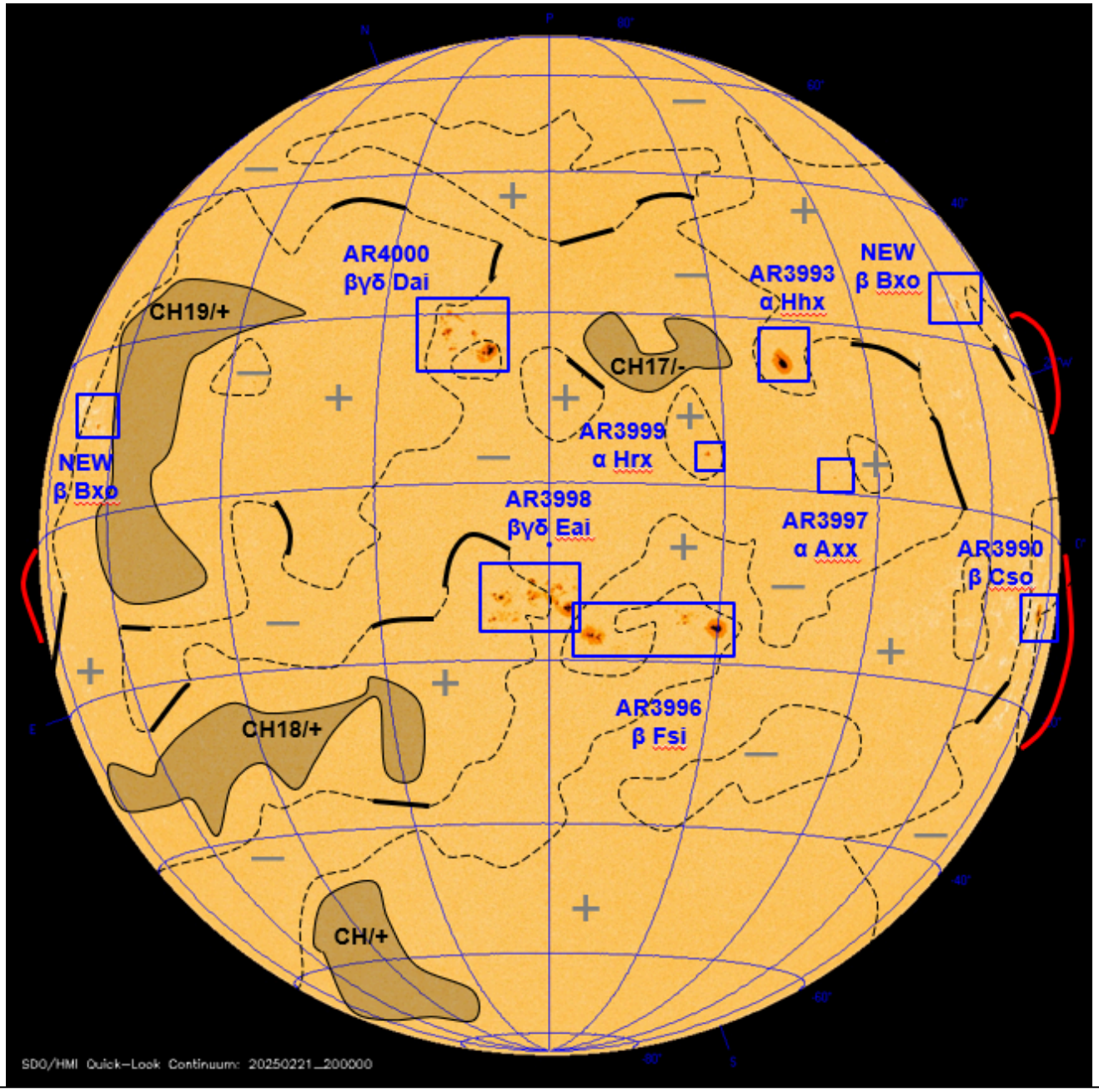
Figure 1: Solar synoptic map, valid 21/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There have been several CMEs over the last few days, some of which are difficult to assess in coronagraph imagery. There are two main features which could have an Earth directed component. The first followed a C8 flare at 19/2345 UTC from a now decayed region in the southwest, with modelling results indicating a chance of a glancing blow around the middle of the day (UTC) on Day 2 (23 Feb). There is a lower chance of the second CME brushing Earth on Day 3 (24 Feb). Overall, confidence in the CME forecast is very low.

Wind speeds are currently at background levels. Late Day 3 or Day 4 (24-25 Feb) a slight enhancement may occur, associated with CH17/-. This is a small, weak feature seen in imagery and at most wind speeds may become slightly elevated around 400-450 km/s. However, as CH17 is negative polarity and the March equinox is approaching, if a connection occurs there may be a slightly greater geomagnetic response to a weak HSS than normally expected.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled at first, but activity may increase to give a chance of G1/Minor Storm (Kp 5) intervals and a slight chance of G2/Moderate Storm (Kp 6) intervals on Days 2-3 mainly due to the risk of CME influence.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	30	30	10
Strong	G3	No	1	5	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
20/0514	Partial	ex-AR3991	SW	438	23/1200UTC +/-9 hours	Chance of a glancing blow.
20/2200	Partial	Uncertain, maybe near AR3996	Uncertain	450	24/0600UTC +/- 12	Slight chance of a glancing blow.

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Figure 2: Enlil ensemble showing the risk of CME glancing blows 23-24 Feb.

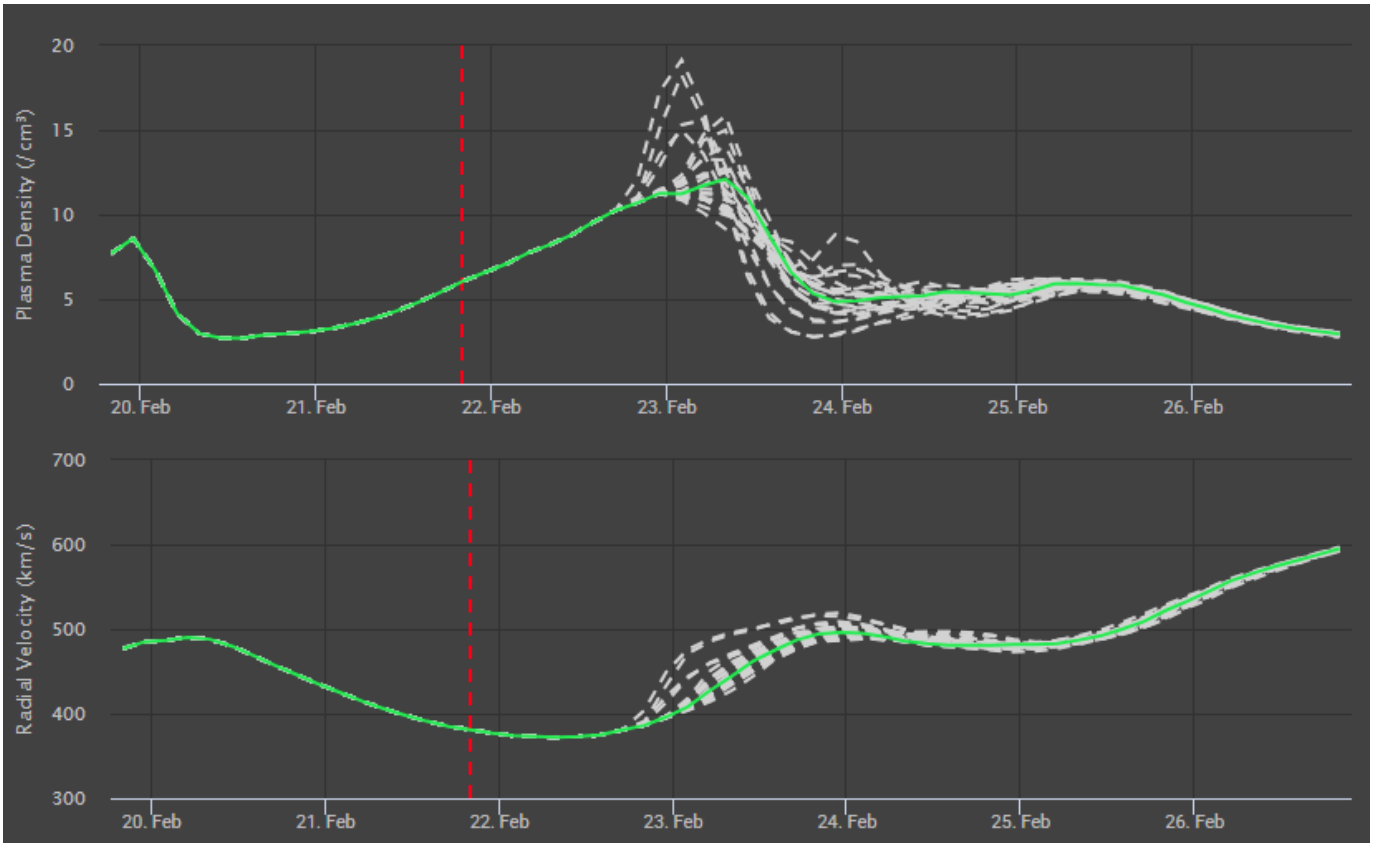

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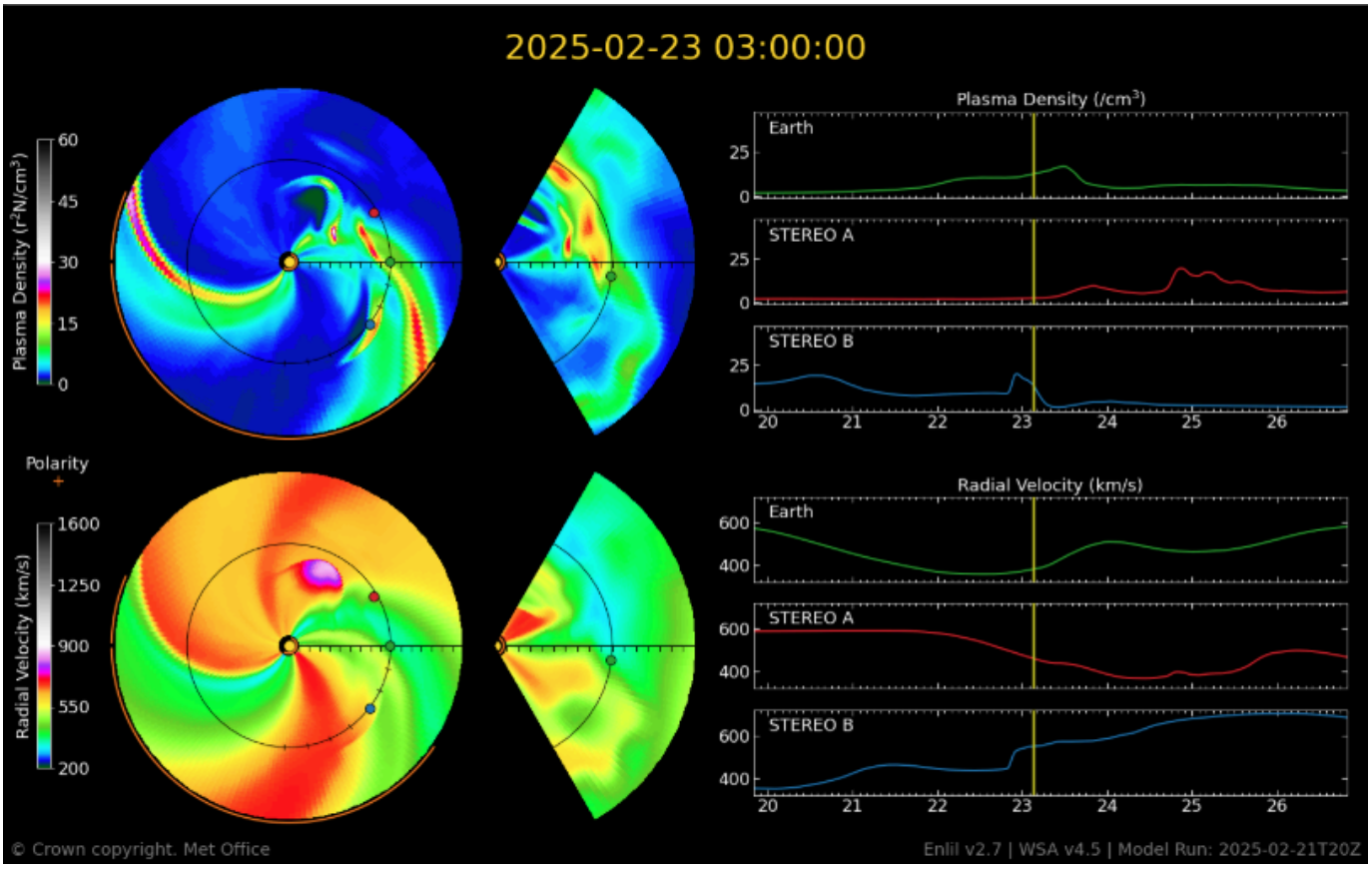
Figure 3: MOSWOC Enlil, which is thought to be over-estimating the wind speed over the next few days.



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Radio Blackouts - X-Ray Flares

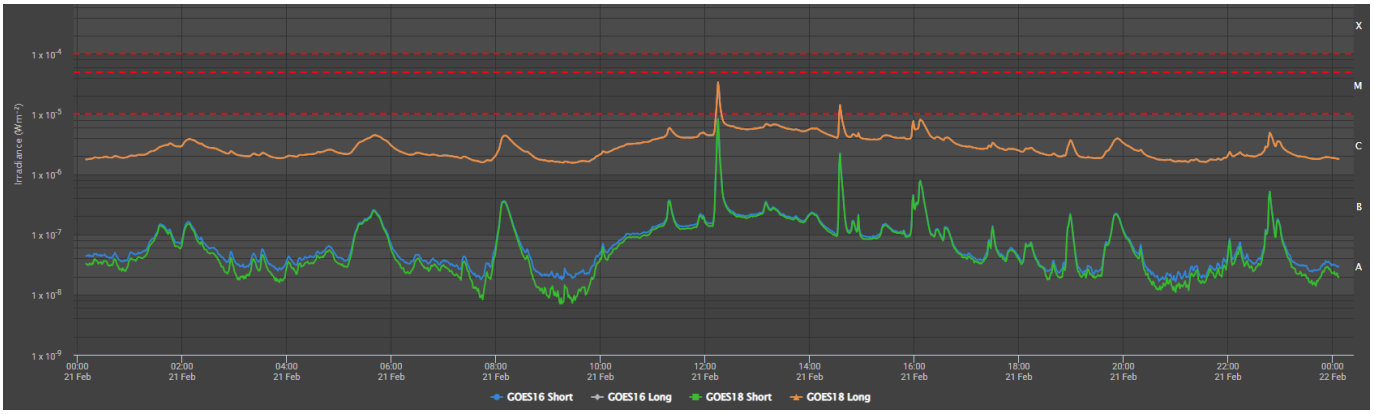
Solar activity has increased to Moderate due to two impulsive M-class flares from AR4000, with a peak M3.3 flare at 21/1215 UTC.

There are currently nine sunspot regions on the visible disc. The most notable regions are now AR3998 at south centre disc and newly numbered AR4000 approaching north centre disc. AR3998 continues to show spot development and magnetic complexity, maintaining a small delta spot within the developing intermediate portion. AR4000 has developed rapidly in the last 24 hours, with a clear delta spot in the trailing portion. AR3996 remains of interest, but despite its length it is straightforward magnetically, and currently appears stable. The other regions on the disc are smaller and simpler at the present time.

The flare probability has been increased, mainly due to the development of AR4000, with M-flares now considered likely and a slight chance of X-flares. This may change if we see alterations in AR4000. There are several regions due to return from the far side in the coming days, but far side seismographs are not detecting any significant regions near the east limb. As such the probabilities have been kept flat through this period pending further developments.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	60	60	60	60
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 4: X-ray flux at GOES16 and 18, showing the two impulsive M-flares from AR4000, alongside a background increase in flux due to a coincident filament lift off in the northwest.



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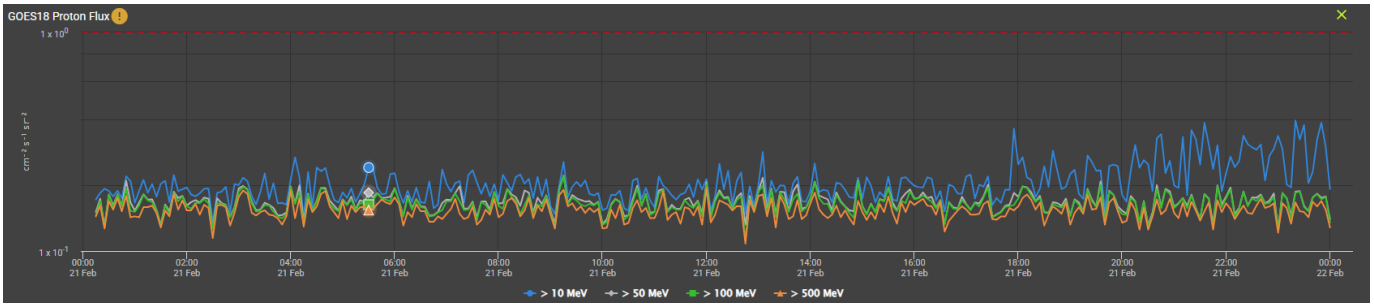
Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux is currently just slightly raised above normal background levels, likely due to either the M3 flare from AR4000 or the coincident west limb filament eruption. The recent rapid development of AR4000 raises the risk of proton flux rising above the S1/Minor radiation storm level a little. Overall, proton flux is most likely to remain at background levels, but with a slight chance of rising in response to larger flares, mainly from AR3996, AR3998 or AR4000.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: Proton flux at GOES18, showing the 10MeV flux raised very slightly above normal background levels.



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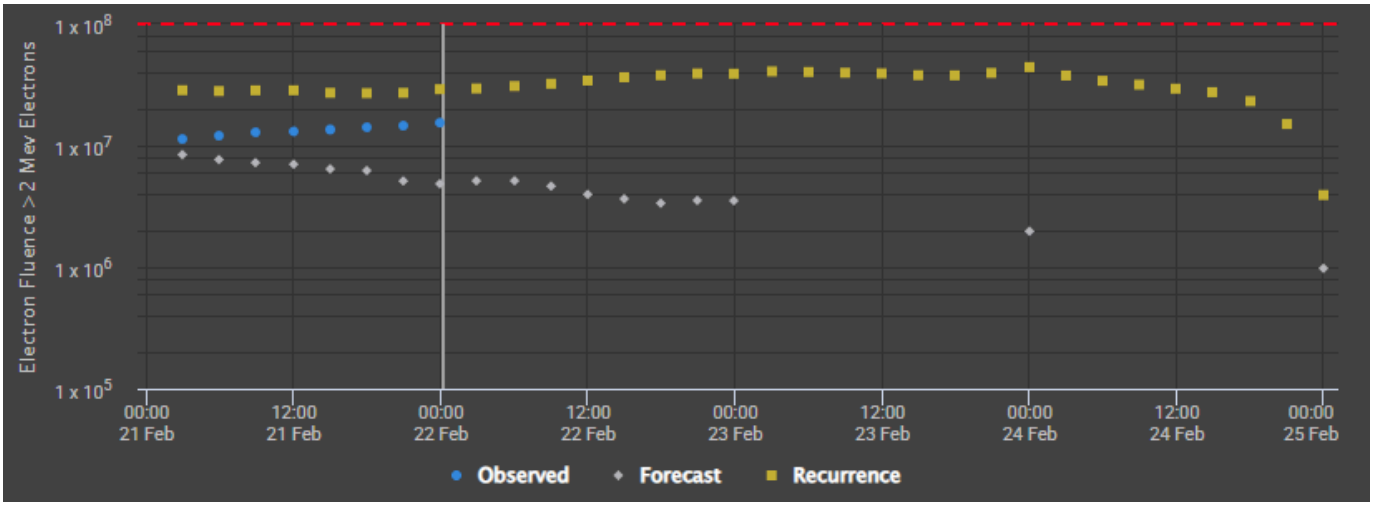
High Energy Electrons (≥ 2MeV)

High energy electron flux, as observed at GOES-16 is now at mostly moderate levels. Now solar winds have eased after the HSS from CH15 and there has been no significant rise in electron flux at GEO, it seems less likely that further diurnally high peaks will be reached. In addition, with potential CME influence in the forecast on Days 2-3 (23-24 Feb), this could help to suppress electron flux during the period.

The associated 24 hour fluence is currently below the Active level, albeit with a very slight rising trend, but is expected to persist below this level. MOSWOC REFM is suggesting a gradual decline in fluence, which seems like reasonable guidance at this time.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	10	10	5	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: MOSWOC REFM, showing a declining trend in forecast values, which seems reasonable.



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